PicoLAS

FOCUSSING POWER TO THE POINT

User Manual - preliminary - Rev. 21.09

LDP-C 18-05 **LDP-CW 18-05**
LDP-C 40-05 **LDP-CW 40-05**

This manual is for all of the above pulsed C and continuous current CW driver units.

The CW version is identical to the C version but with a fixed pulse width of indefinite.

Please note the specifications are different for different units. In case of doubt please refer to the corresponding data sheet.

Before powering on your unit, read this manual thoroughly and make sure your understood it fully.

Please pay attention to all safety warnings.

If you have any doubt or suggestion, please do not hesitate to contact us!

PicoLAS GmbH
Company for Innovative Power Electronics und Laser Technology

Kaiserstraße 100
52134 Herzogenrath

Tel: +49(0)2407-563 58-0
Fax: +49(0)2407-563 58-29
E-Mail: info@picolas.de
Web: www.picolas.de

PicoLAS
FOCUSSING POWER TO THE POINT

Table of Contents

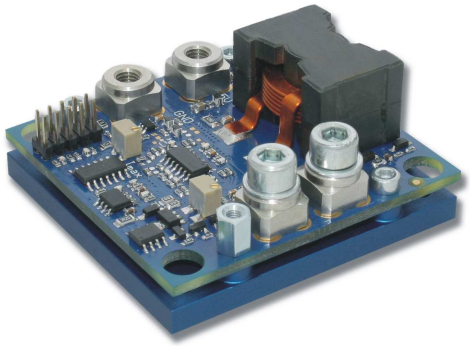
LDP-C 18-05 data sbeet 3
LDP-C 40-05 data sheet 4
Description of Connections and Jumpers 5
How to get started 6
Dos and Don'ts (LPD-C 40-05, LDP-C 18-05) 6
Functional Description 7
Interface Specification 8
Active Current Limit 9
Current Rise Time Adjustment 9
Effect of Laser Diode Connection on the Pulse Shape 10
Test Load 10
Analog Modulation 10
Power Supply 11
Soft Start 11
Cooling 11
Over Temperature Shutdown 13
Absolute Maximum Ratings 13
Mechanical Dimensions 13

PicoLAS
FOCUSSING POWER TO THE POINT

Rev. 09.03 valid from June 2009

LDP-C 18-05

Driver for High Power Laser Diodes



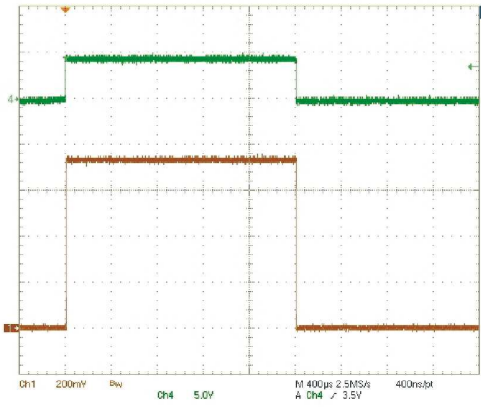


Figure: Current monitor output, scale: 5 A/Div

- Output current: 1 .. 18 A
- Output current between pulses: 0 A
- Compliance Voltage: 1 .. 5 V
- Coverage of both cw and qcw range
- Analog modulation up to 16 kHz
- Half-Brick size OEM-Module
- Several protective features
- Adjustable current rise time
- High efficiency

Technical Data:*

Output current	1 .. 18 A
Max. compliance voltage	5 V
Typ. pulse rise time (10 A)	400 ns .. 1 µs (adjustable)
Typ. pulse trigger delay	200 ns **
Min. pulse duration	< 1 µs
Max. pulse duration	cw
Max. repetition rate	500 kHz
Current ripple	< 200 mA, > 400 kHz
Current overshoot	< 1 %
Analog modulation (5 A_{pp})	< 16 kHz
Current settling time (full-scale)	< 150 µs
Pulse trigger input	5 V TTL into 500 Ω
Current setting input	0 .. 0.72 V external (25 A/V)
Current monitor	25 A/V
Voltage monitor	0.1 V/V
Supply voltage	4 .. 6 V DC (at least 1 V above compl. voltage)
Max. power dissipation	12 W
Dimensions in mm	60.9 x 57.8 x 54 Half-Brick size
Weight	194 g
Operating temperature	0 to + 55 ° C

* Specifications measured with a fast recovery diode instead of a laser diode.
Technical data is subject to change without further notice.
** Max 2 µs at longest rise time

Product Description:

The LDP-C 18-05 OEM is a very affordable, compact and efficient current supply to drive e.g. the OSRAM Sirilas (registered trademark of OSRAM).
The pulsing capability ranges from single pulses over several hundred kilohertz repetition frequency up to continuous operation. Besides pulsing the diode, analog modulation of the output current is also possible. Its intended field of application is laser soldering and welding as well as generic surface treatment.
The innovative current regulation concept of the LDP-C 18-05 produces, compared to the commonly used linear regulation concept, considerably less losses. Hence only one supply voltage is needed for the control logic and the power stage. The current consumption drawn from the power supply only needs to cover the average laser power and is typically much less than 18 A.

Designed to shield your laser diode from damage, the LDP-C 18-05 features a number of powerful protective safeguards:

- Innovative current regulation concept actively prevents laser diode from overshoots and over-current
- Integrated Soft Start
- Protection against transients through regulated current rise time
- Over-temperature shutdown
- Enable/Disable input
- Pulser status output
- Shunt MOSFETs short the output clamps in case of an error
- Protection of the laser diode against reverse currents

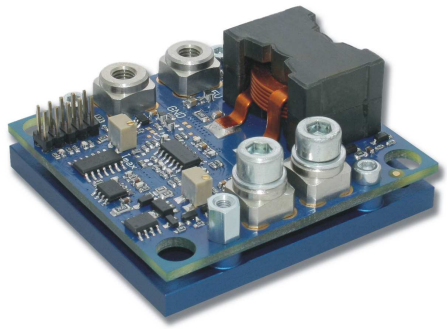
Optional Accessories: LDP-C-BOB

PicoLAS
FOCUSSING POWER TO THE POINT

Rev. 09.03 valid from June 2009

LDP-C 40-05

Driver for High Power Laser Diodes



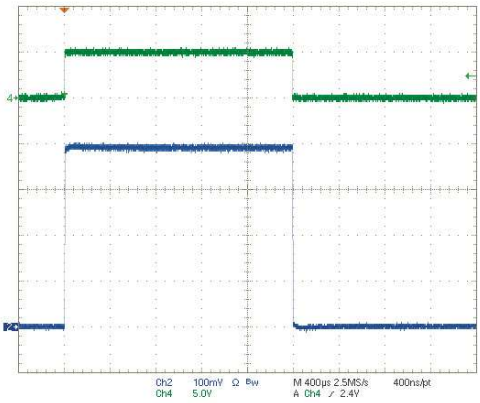


Figure: Current monitor output, scale: 10A/Div

- Output current: 1 .. 40 A
- Output current between pulses: 0 A
- Compliance Voltage: 1 .. 5 V
- Coverage of both cw and qcw range
- Analog modulation up to 16 kHz
- Half-Brick size OEM-Module
- Several protective features
- Adjustable current rise time
- High efficiency

*Technical Data:**

Output current	1 .. 40 A
Max. compliance voltage	5 V
Typ. pulse rise time (10 A)	400 ns .. 1 µs (adjustable)
Typ. pulse trigger delay	200 ns **
Min. pulse duration	< 1 µs
Max. pulse duration	cw
Max. repetition rate	500 kHz
Current ripple	< 400 mA, > 200 kHz
Current overshoot	< 1 %
Analog modulation (10 A_{pp})	< 16 kHz
Current settling time (full-scale)	< 60 µs
Pulse trigger input	5 V TTL into 500 Ω
Current setting input	0 .. 1.6 V external (25 A/V)
Current monitor	25 A/V
Voltage monitor	0.1 V/V
Supply voltage	4 .. 6 V DC (at least 1 V above compl. voltage)
Max. power dissipation	30 W
Dimensions in mm	60.9 x 57.8 x 54 Half-Brick size
Weight	194 g
Operating temperature	0 to + 55 ° C

* Specifications measured with a fast recovery diode instead of a laser diode.
Technical data is subject to change without further notice.
** Max 2 µs at longest rise time

Product Description:

The LDP-C 40-05 OEM is a very affordable, compact and efficient current supply to drive e.g. the OSRAM Sirilas (registered trademark of OSRAM).
The pulsing capability ranges from single pulses over several hundred kilohertz repetition frequency up to continuous operation. Besides pulsing the diode, analog modulation of the output current is also possible. Its intended field of application is laser soldering and welding as well as generic surface treatment.
The innovative current regulation concept of the LDP-C 40-05 produces, compared to the commonly used linear regulation concept, considerably less losses. Hence only one supply voltage is needed for the control logic and the power stage. The current consumption drawn from the power supply only needs to cover the average laser power and is typically much less than 40 A.

Designed to shield your laser diode from damage, the LDP-C 40-05 features a number of powerful protective safeguards:

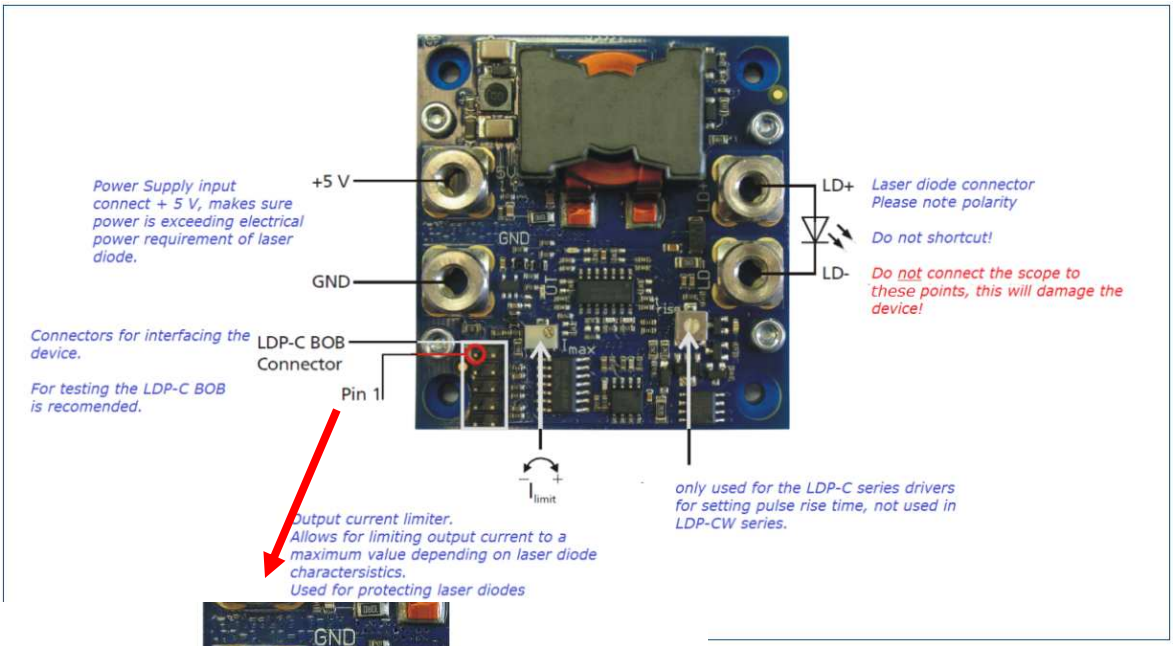
- Innovative current regulation concept actively prevents laser diode from overshoots and over-current
- Integrated Soft Start
- Protection against transients through regulated current rise time
- Over-temperature shutdown
- Enable/Disable input
- Pulser status output
- Shunt MOSFETs short the output clamps in case of an error
- Protection of the laser diode against reverse currents

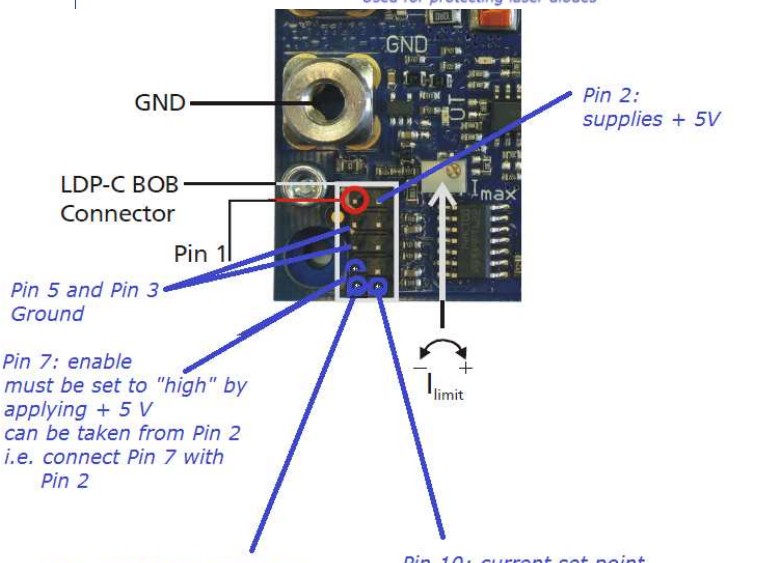
Optional Accessories: LDP-C-BOB

Description of Connections and Jumpers

The following drawing shows all connections and potentiometers that are available to the user.

LDP-C BOB	**Connector for Break Out Board.** See page 8 for detailed information.
T_{rise}	Poti for current rise time adjustment.
+5V	Supply voltage
GND	Supply ground
LD+	Positive laser diode output (anode).
LD-	Negative laser diode output (cathode). Do not connect to ground!
I_{limit}	Poti for active current limit





For a more convenient use of the diode driver (e.g. for laboratory use) we recommend the optional available product **LDP-C-BOB**. Please see LDP-C-BOB manual for further details.

PicoLAS
FOCUSSING POWER TO THE POINT

How to get started

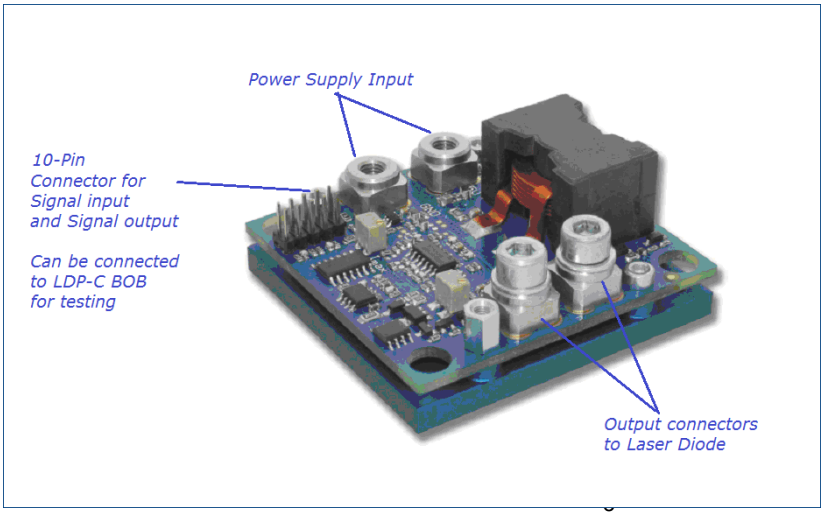
Step #	What to do	Note
1	Unpack your device; place it in front of you like shown on the previous page.	
2	Apply a dummy load at the output (e.g. a Fast-Recovery-Diode). The Laser Diode output is on the right side, please note polarity.	Dummy load must be a valid equivalent to a laser diode (e.g. concerning parasitic capacitance, compliance voltage)
3	Set the current setpoint input to 0. This is done by feeding 0 V into Pin 10	Connect a voltage source or a potentiometer to pin 10 of the BOB connector and set it to 0 V.
4	Connect a pulse source to the triggering input on Pin 6. (only for LDP-C Series)	e.g. 100 µs, 5 V TTL, 100 Hz.
5	Connect a scope to the diode current monitor output I_{Diode} on Pin 9. Ground is on Pin 3 or Pin 5.	Select high impedance termination, trigger on positive rising edge, 200 mV/div.
6	Apply the supply voltage. (+5 V DC) Input for the supply voltage are the two contacts (screws) on the left, please note polarity.	Make sure that the supply voltage can deliver enough energy to be stable during the pulses.
7	Set enable Pin 7 to "high". + 5 V voltage might be taken from Pin 2	Apply +5 V to pin 7 of the BOB connector.
8	Adjust the setpoint value to the desired pulse current. Connect voltage source to Pin 10.	Apply a appropriate voltage to pin 10. Scale: 25 A/V
9	Disconnect the supply, remove the dummy load at the output and assemble the Laser Diode.	Pay attention to the polarity of the Laser Diode!

Dos and Don'ts (LPD-C 40-05, LDP-C 18-05)

Never ground any lead of the output. This will immediately destroy the driver!

Never use any grounded probes (e.g. the Oscilloscope) at the output. This will immediately destroy the driver and the probe!

Never make a short at the output. This will not do any harm to the laser diode driver but will yield in an incorrect current measurement.


Power Supply Input
10-Pin Connector for Signal input and Signal output
Can be connected to LDP-C BOB for testing
Output connectors to Laser Diode

Keep connection between power supply and the driver as well as the connection between driver and laser diode as short as possible.

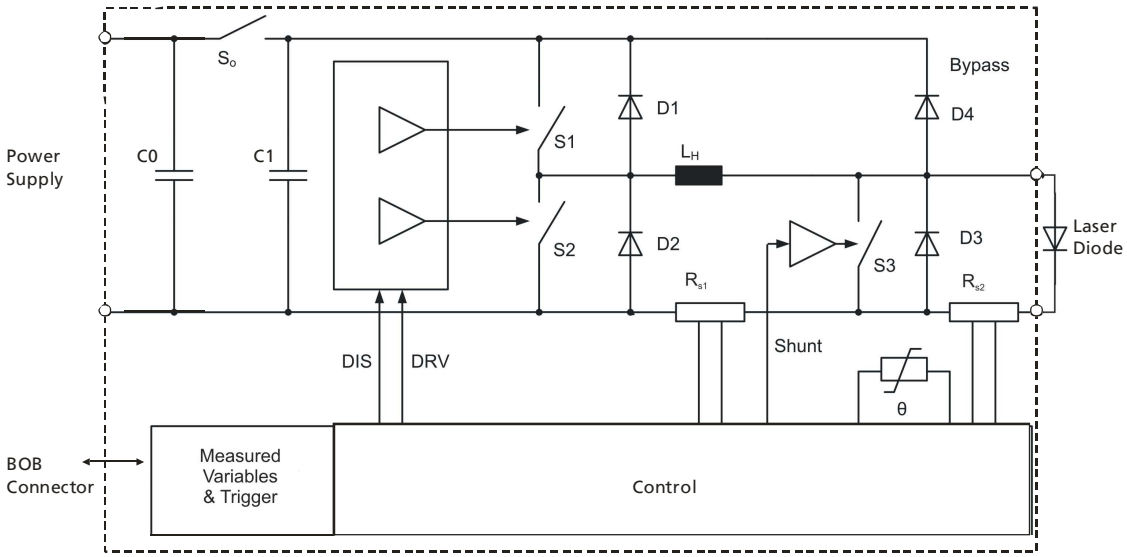
Mount the driver on an appropriate heat sink.

Functional Description

The LDP-C 40-05/18-05and LDP-CW 40-05/18-05 operate by the following principle: A buck converter (S1, S2, D1, D2, LH) generates a current in its inductor L_H. This current is shorted to ground through the shunt MOSFET S3. During a pulse, S3 is open and the current flows through the laser diode LD. The inductor current through L_H is measured with R_{S1}, this allows the control circuit to regulate the current to a constant value under all circumstances. The laser diode current is measured with R_{S2}. Blocking capacitors decouple the driver from the power supply. C1 filters the high frequency ripple of the buck converter.

Inductor current, laser diode current and compliance voltage are pre-processed and then lead to the external BOB-connector. A trigger input for generating pulses and an enable-input as well as s status output are available.

Several security features protect the laser diode and driver from damage. D3 protects the laser diode from reverse currents; bypass diode D4 protects the driver in case of a load failure. To protect the laser diode during start-up of the driver, S0 remains opened until the supply voltage has reached a stable level. In case of an over temperature condition, the control logic disables the driver. A soft-start mechanism slowly rises the current after an over temperature shutdown or at startup.



Operation Principle of LDP-C / LDP-CW diode driver

Element	Function
S0	Security Switch
C1, S1, S2, D1, D2	Buck Converter
C0	Input Buffer Capacitor
S3	Shunt Mosfets Short Output
D3, D4	LD-Protection
RS1	Current sensor for Regulation (Control)
RS2	LD-current monitor
θ	Temperature-sensor

PicoLAS
FOCUSSING POWER TO THE POINT

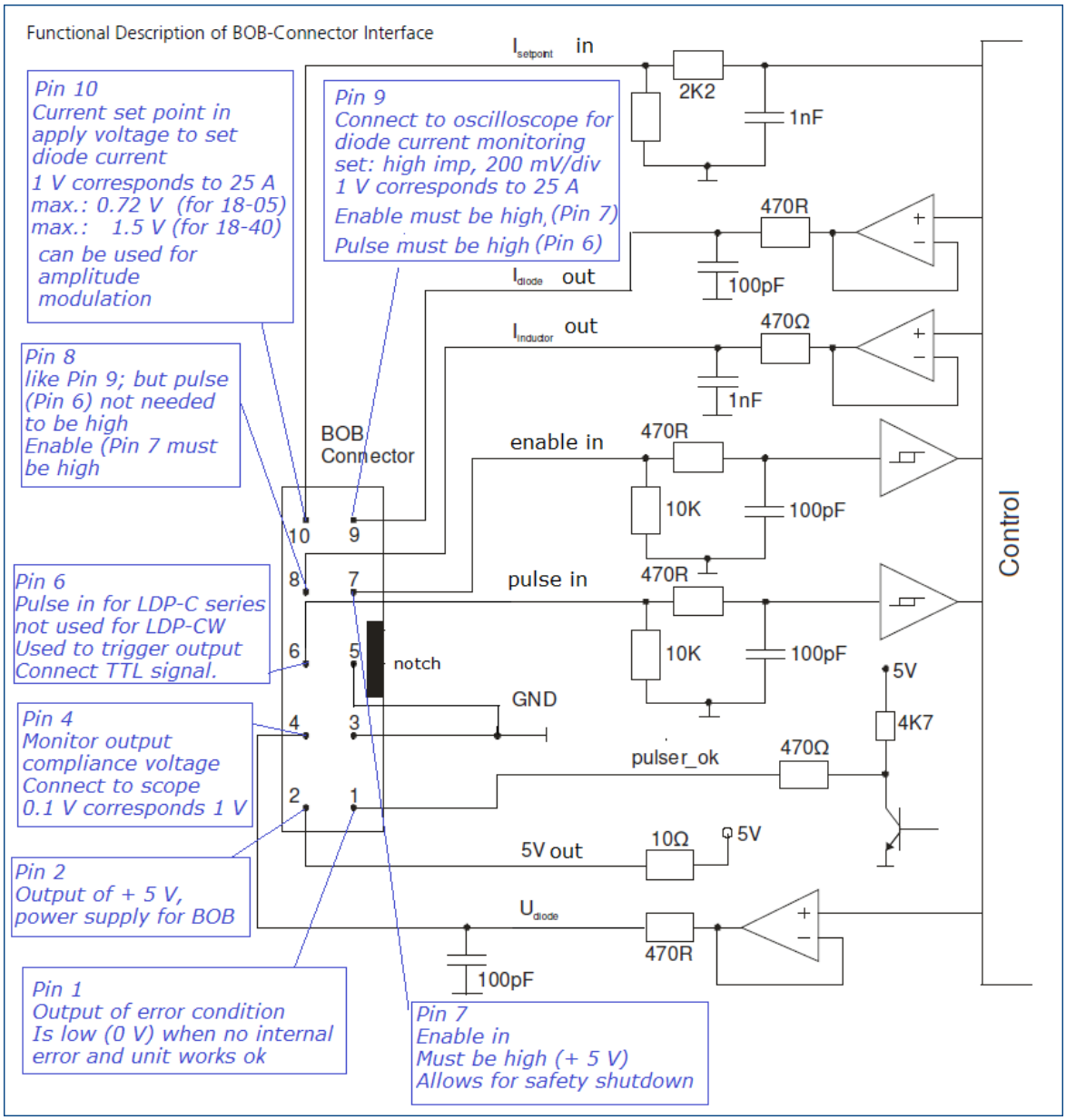
Interface Specification

The following figure shows the input and output stages of the external analog BOB connector. The monitoring outputs (Pin 8 and Pin 9) are filtered and buffered to improve signal quality.

Digital inputs (enable and pulse-trigger, Pin 7 and Pin 6) are filtered to reduce spikes and then evaluated by Schmitt-triggers to ensure proper evaluation. Similarly, the external current setpoint input is filtered. All inputs are protected by clamping diodes against over voltage.

The pulser_ok output (Pin1) is high during normal operation and pulled low in case of an over temperature alert.

An auxiliary stabilized high impedance 5 V supply voltage is provided (Pin2) to power e.g. the LDP-C BOB.



Active Current Limit

The LDP-C 40-05/18-05 and LDP-CW 40-05/18-05 provide an active laser diode current limit feature. With help of the current limit potentiometer (see pictures o page 5), the user can adjust the maximum current which will flow through the laser diode.

To adjust the current limit to the desired value, follow the steps below:

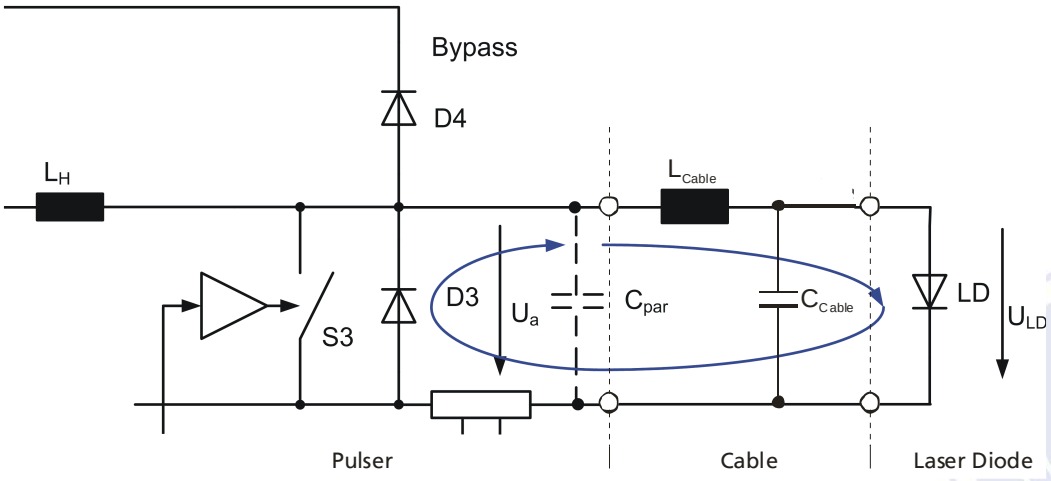
1. Disconnect any load from the output. Disconnect any trigger source (applies only for LDP-C Series) connected to the trigger input (Pin 6).
2. Apply 1.6 V = 40 A (for LDP-C(W) 40-05) or 0.72 V = 18 A (for LDP-C(W) 18-05) to the current setpoint input (Pin 10).
   Apply the supply voltage (input connectors on the left).
3. Monitor inductor current output signal (Pin 9 or Pin 8, see drawing on previous page) and adjust the current limit to the desired value by turning the potentiometer counter clockwise (left potentiometer in pictures on page 5).
4. Disconnect power supply and mount a test load (diode) to the driver.
5. Apply the power supply (and trigger source (Pin 6) for the LDP-C Series) . Vary the current setpoint input and verify the current limit by monitoring the laser diode current (Pin 9 or Pin 8).
6. The current limit function is all set and ready for use.

Note: Although the active current limit function is very robust against disturbances, it only works reliable if the driver is fully functional. Any damage caused e.g. through over voltage at the setpoint input may harm the current limit function.

Current Rise Time Adjustment (applies to LDP-C Series only)

The LDP-C 40-05/18-05 provides current rise time adjustment of the positive edge of a pulse. When the shunt switch S3 closes, the inductor current through L_H commutates from S3 to the output. There it has to magnetize the parasitic inductance L_{cable} due to cables between diode driver and laser diode. During this process, the current through the laser diode rises. The rise time depends on the voltage difference between the output of the diode driver and the laser diode compliance voltage, the current through L_H and the parasitic inductance itself. Obviously higher parasitic inductances result in slower current rise time and thus higher rise times. Equally a higher current results in a higher rise time. With a higher compliance voltage, the voltage difference between diode driver output and laser diode decreases and thus the rise time increases.

With the poti t_{rise} on the controller board, the user can influence the voltage rise of the output voltage of the diode driver and thus the rise time of the laser diode current. However, as the rise time depends mainly on the cabling as well as on the chosen current and compliance voltage of the load, no absolute relation for the current rise time can be given.



Effect of Laser Diode Connection on the Pulse Shape
(applies to LDP-C Series only)

Parasitic elements in diode driver and connection line to the laser diode have an important influence on pulse shape and rise time. The parasitic output capacitance of the pulse C_{par}, the cabling inductance L_{cable} and the parasitic capacitance of the diode C_{diode} form a resonant circuit. Applying a step function (which is done at the beginning of a pulse) on a resonant circuit results in oscillations and current overshoot. As these oscillations are inacceptable for most laser applications, the parasitic capacitances and inductances have to be minimized.

Laser diodes usually have a very low parasitic capacitance in the order of some 10 pF. Together with a short and low inductive connection between laser diode and driver no oscillations or overshoot should occur. In addition, the adjustable current rise time helps to avoid overshoot and oscillations. A very short rise time and thus a very high current rise results in a strong excitation of the resonant circuit. With a longer rise time and softer current rise the resonant circuit is considerably less excited and though oscillations and overshoot will not appear.

As already mentioned above, L_{cable} influences the current rise time at the beginning of the pulse. Because L_{cable} has to be magnetized up to the inductor current which flows through L_H, a higher L_{cable} yields in a longer rise time. At the end of a pulse S3 closes and shorts the output. Then L_{cable} has to be demagnetized. At this time, only a very low voltage is available at the output. The time required to demagnetize L_{cable} depends only on its value. Higher L_{cable} results in a longer current fall time.

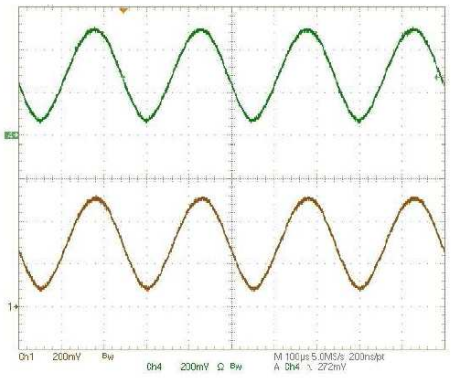
Test Load

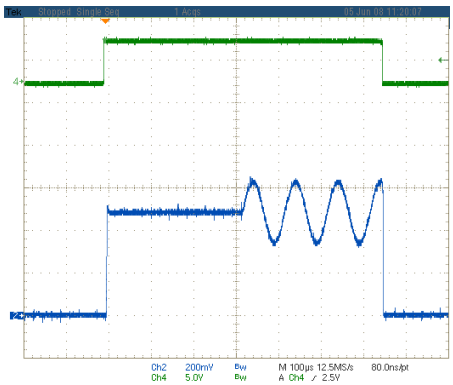
A common method to test the driver is to connect a regular **silicon rectifier diode** to the driver output. Do not connect to a resistive load, output voltages are too high!
For the **LDP-C Series** attention has to be paid to the junction capacitance of the diode. Only **fast recovery diodes** (or equivalents) have as low a parasitic capacitance as laser diodes have. To achieve reasonable test results, the parasitic elements of the test diode and the connection must be very similar to the laser diode approach. Regular silicon rectifier diodes have a junction capacitance of several microfarads and are not a suitable test load! The use of these diodes will yield in incorrect current measurement at the pulse edges!

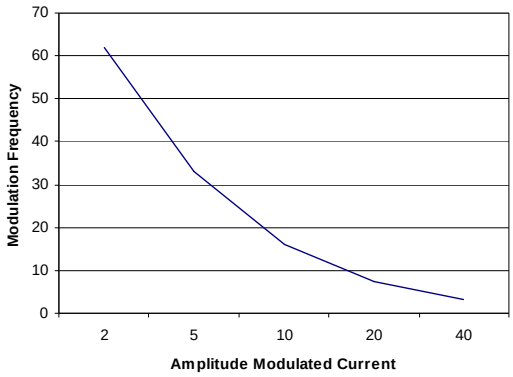
Analog Modulation

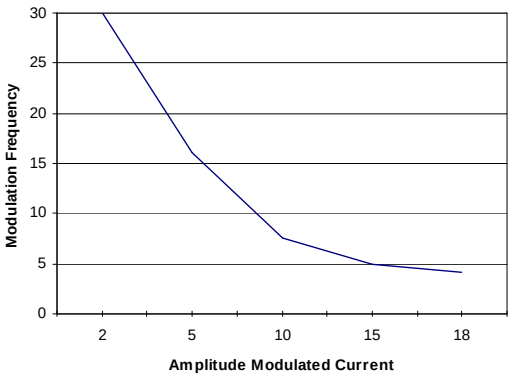
The LDP-CW 40-05, LDP-CW 18-05 and the LDP-C 40-05, LDP-C 18-05 are all capable of modulating the output current controlled via the current set-point input (Pin 10).

The maximum modulation frequency depends on the modulation amplitude of the current. With higher modulation amplitudes lower frequencies will be achieved and vice versa. Best modulation results are achieved when the laser diode compliance voltage equals half the supply voltage.









Analog modulation for LDP-CW series
Analog modulation for LDP-C Series

Analog Modulation capability of LDP-C(W) 40-05 (left) and LDP-C(W) 18-05 (right)

The above graphs show the modulation frequency in dependence of the setpoint modulation amplitude. The frequency values where determined at the point where the output current amplitude dropped to 90% of the setpoint modulation amplitude.

Power Supply

To obtain a good pulsing performance with the LDP-C 40-05/18-05 and the LDP-CW-40-05/18-05, the drvers require an appropriate power supply unit (PSU). The PSU has to supply the power that is delivered to the laser diode and also to make up for the losses in the driver itself. It has to be taken into account that the laser diode power varies strongly when the diode is pulsed or the output current is modulated. Although the drivers are usually equipped with a large input capacitance of 23.5 mF to buffer these power peaks, the power supply has to deliver the required power fast enough to avoid input voltage drops. For excessive pulsing or modulation of the output current, the PSU output impedance as well as the line impedance between PSU und diode driver has to be as low as possible.

When the input voltage drops below 2.5 V the driver shuts down automatically. This in turn results in a rise of the input voltage and the driver starts working again. This will cause the input voltage to drop again if the PSU is too weak to deliver the required power. The result is an unwanted oscillation of the input voltage and thus a malfunction of the driver. A further protection against these oscillations is the soft start mechanism at power-up.

Soft Start

The LDP-C 40-05/18-05, LDP-CW 40-05/18-05 drivers apply a soft start mechanism that is activated upon power-up and after an over temperature alert. This mechanism ramps up the active current limit from 0 A (at the beginning) to the configured current limit value with a speed of approx. 2 A/ms. This protects the power supply from excessive current peaks, if the diode driver is already enabled and a pulse is applied at the trigger input during power up.

Cooling

The LDP-C 18-05 and the LDP-CW-18-05 produce up to 12 W of losses. Thus the base plate has to be mounted on a heat sink to ensure proper operation and prevent an over temperature shutdown.
In case of the LDP-C 40-05 and LDP-CW-40-05 some more attention has to be paid to the cooling. The maximum power dissipation here is up to 30 W. With currents above 30 A not only the base plate

has to be cooled properly, but also the power inductor on the board. This can be achieved easily by placing the driver with its heat sink into the air current of a fan.

Over Temperature Shutdown

To protect the laser diode and the driver, the unit automatically disables itself if the temperature rises above 80 °C. This condition is not latched and the diode driver will start working as soon as the temperature falls below 75 °C. During the over temperature shutdown, the "pulser_ok" output (Pin 1 on the BOB-Connector) is pulled low.

Absolute Maximum Ratings

- Supply voltage range: +2.5 V .. +6 V
- Maximum input current: 40 A (40-05); 18 A (18-05)
- Maximum laser diode output current: 40 A (40-05); 18 A (18-05)
- Maximum laser diode compliance voltage: 5 V
- Maximum pulse repetition rate: 500 kHz (applies to LDP-C Series only)
- BOB-connector input and output voltages: 0 V to 5 V
- BOB-connector output currents: 1 mA
- Auxiliary 5 V supply voltage output current: 30 mA
- Operating temperature: 0 - 55 °C

Mechanical Dimensions

Mount holes diameter: 3,2 mm
Over all height (without C-Bank): 27,0 mm
Over all height incl. C-Bank: 54,0 mm
All dimensions in mm